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## PROBLEMS.

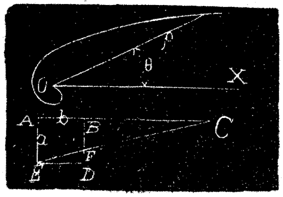
**43. Proposed by Professor C. E. WHITE, A. M., Trafalgar, Indiana.**

Prove that $\int_2^1 \frac{x^{a-1}+x^{-a}}{1+x} \cdot \frac{dx}{x} = \log\left(\tan\frac{a\pi}{2}\right)$, when $a>0$ and $<1$.

[*Williamson's Int. Calculus, p. 154.*]

**44. Proposed by DE VOLSON WOOD, C. E., Professor of Mechanical and Electrical Engineering in Stevens Institute of Technology, Hoboken, New Jersey.**

Find the equation of a curve in which $\rho=f(\theta)$, in which $\rho$ is equal to $BC$, an intercept of any secant drawn from the corner $E$ of the rectangle $AEDB$, and prolonged to cut $AB$ prolonged in $C$. Let equal increments of $\theta$ be proportional to the equal increments of $DB$ as divided by the secant $EF$, $\theta$ being zero when $EC$ coincides with $ED$, and $\theta=2\pi$ when $EF$ passes through $B$. Determine the asymptotes.



[Prof. Mac Cord of Stevens Institute, while investigating the curve of intersection of a plane with the surface of a certain volume, found that it had the property of the above problem, and he referred it to Professor Wood to investigate in regard to asymptotes. If the curve is not known to science, Professor Mac Cord desires to christen it as "The Thistle of Scotland."]

## MECHANICS.

**Conducted by B. F. FINKEL, Springfield, Mo. All contributions to this department should be sent to him.**

**23. Proposed by ALFRED HUME, C. E., D. Sc., Professor of Mathematics, University of Mississippi, University Post Office, Mississippi.**

A heavy particle is placed upon the surface $\sqrt{x}+\sqrt{y}+\sqrt{z}=c$. The axis of $z$ being vertical and the coefficient of friction being $\sqrt{2}$, show that a point of equilibrium (all friction possible being brought into action) $z$ is a harmonical mean between $x$ and $y$.

**I. Solution by WILLIAM HOOVER, A. M., Ph. D., Member of London Mathematical Society and Professor of Mathematics, Ohio University, Athens, Ohio.**

If $X$, $Y$, $Z$ be the forces of which $P$ is the resultant independent of the reaction of the surface on the particle parallel to the co-ordinate axes, $\mu=\sqrt{2}=$ the coefficient of friction, and $\mu=0$ the equation to the surface, for limiting equilibrium we have

$$\left(X\frac{du}{dx}+Y\frac{du}{dy}+Z\frac{du}{dz}\right)^2 \div P^2\left(\frac{du^2}{dx^2}+\frac{du^2}{dy^2}+\frac{du^2}{dz^2}\right)=\frac{1}{1+\mu^2}\ \ldots(1),$$

the derivatives being partial.

We have $u=\sqrt{x}+\sqrt{y}+\sqrt{z}-c=0\ \ldots(2)$, whence $\frac{du}{dx}=\frac{1}{2\sqrt{x}}$, $\frac{du}{dy}=\frac{1}{2\sqrt{y}}$, $\frac{du}{dx}=\frac{1}{2\sqrt{z}}$ ....(3).

Also, $X=Y=0$, $Z=-g=P$....(4).

Substituting in (1) and reducing, $z=\frac{2xy}{x+y}$....(5).

**II. Solution by ALFRED HUME, C. E., D. Sc., Professor of Mathematics, University of Mississippi.**

If $W$ is the weight of the particle, $N$ and $T$ its normal and tangential components,

$$W^2=N^2+T^2.$$

Also, when the particle is on the point of sliding,

$$T=\sqrt{2}\,N.$$

Hence $W^2=3N^2$.

Again $W\cos\theta=N$, $\theta$ being the angle between the normal and the $Z$-axis.

Now $\cos\theta=\dfrac{\frac{dF}{dz}}{\sqrt{\left(\frac{dF}{dx}\right)^2+\left(\frac{dF}{dy}\right)^2+\left(\frac{dF}{dz}\right)^2}}$, $F(x, y, z)=0$ being the equation of the surface, and the differential-coefficients being partial.

$$\frac{dF}{dx}=\frac{1}{2\sqrt{x}},\quad \frac{dF}{dy}=\frac{1}{2\sqrt{y}},\quad \frac{dF}{dz}=\frac{1}{2\sqrt{z}};$$

and, therefore, $\cos\theta=\dfrac{\frac{1}{\sqrt{z}}}{\sqrt{\frac{1}{x}+\frac{1}{y}+\frac{1}{z}}}$.

But $W^2\cos^2\theta=N^2=\frac{W^2}{3}$, from which $3\cos^2\theta=1$.

Substituting, $\frac{3}{z}=\frac{1}{x}+\frac{1}{y}+\frac{1}{z}$, or $\frac{2}{z}=\frac{1}{x}+\frac{1}{y}$, and $z$ is a harmonical mean between $x$ and $y$.

Solutions of this problem were also received from *F. P. MATZ* and *G. B. M. ZERR*.

**24. Proposed by J. F. W. SCHEFFER, A. M., Hagerstown, Maryland.**

A sphere whose center of gravity does not coincide with its geometrical center is placed on a rough inclined plane. State under what circumstances the sphere will slide without rolling, roll without sliding, and neither roll nor slide.

**Solution by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics, Irving College, Mechanicsburg, Pennsylvania.**

On a horizontal plane, the sphere will neither roll nor slide; but it will *rock* about the vertical drawn through the point of support. Down an inclined plane, the sphere will roll without sliding, until the *initial horizontal plane* through which the centroid has (by the rolling) become a *vertical* plane. So